"ing rooms, furniture, and chimneys, together with the "damage thus created, we shall find no great reason for con- "cluding that the general use of gas as a heating agent, is "either an impossible or an improbable event in the pro- "gressive march of real civilization."

Mr. Thompson's remarks are made for, and applied to, a climate much colder than that of these colonies, and where heat at most seasons of the year is enjoyable rather than otherwise; but a cheap supply of good gas for heating and cooking purposes is a matter of more importance here than in the British Isles, inasmuch as in this climate, where the temperature ranges in summer from 70° to 100° Fah., the principal desideratum is to avoid as much as possible the use of fire for cooking purposes. In the country districts fires can be, and are, generally made out of doors; and thus the heating of dwelling-house apartments is avoided. However, in the city, this can rarely be done, on account of the danger and inconvenience of open-air fires. It only requires a little time to prove beyond all doubt that ordinary culinary operations can be performed at less cost with gas, in conjunction with the use of Norwegian heat-retaining stoves, than by any other means; that is if freedom from dust, a longer duration of heat, a greater economy of time, and a less necessity of unremitting attention, be considered of any monetary value.

ART. III.—*η Argûs and surrounding Nebula.* By A. LE SUEUR, ESQ.

[Read 14th February, 1870.]

At the request of your president I have drawn up the following account of some observations which I have lately made with the great Melbourne telescope.

One important fact elicited may be stated in few words; the spectrum of the star η Argûs is crossed by bright lines.

The abnormal variations in magnitude to which this star is subject gave reason to expect that some peculiarity in its light would be revealed by the spectroscope; as soon, therefore, as the instrumental and atmospheric conditions were sufficiently favourable, a careful examination was made.

The first night employed was fortunately a good one, so that the bright line character, which might otherwise have easily escaped notice, was at once suspected.

Many stars (mostly variables, I believe) give spectra whose dark lines are arranged in bands, leaving more or less bright spaces between them. It became, therefore, of importance to ascertain whether or not the appearance of the spectrum of η Argûs was due to such peculiarity.

Stars of about equal magnitude were therefore examined; in some spectra, notably in that of the red variable R Leporis, there appeared to be a condensation in the yellow, but in none was the general phenomenon so sharply marked as in η Argûs.

Besides this evidence, the fact (as will be seen in the sequel) that the bright lines in η Argûs are readily and reasonably accounted for in their proper positions, leaves very little doubt that the majority of them are real.

Moreover it is quite an open question whether the band character of spectrum spoken of may not be partly due to the condition which produces bright lines. In α Orionis, for instance, it seems at least as plausible to assume the presence of that condition which produces bright hydrogen lines, as to deny the presence of hydrogen altogether.

The phenomenon is necessarily delicate, but by careful manipulation the lines may be handled in a sufficiently satisfactory manner to determine their refrangibilities within not wide limits.

For the purpose of comparing a known spectrum with that of a star, the spectroscope is furnished with a reflector in front of the slit. A small hole in this reflector permits the passage of the star pencil, and the comparison light may at the same time be reflected through the apparatus.

In this way five lines have been determined more or less satisfactorily.

One in the red coincides with *C*, one in the blue with *F*, thus indicating the presence of hydrogen.

A third line in the yellow apparently coincides with *D* sodium line, two in the green with the chief nitrogen line and *b* respectively; a sixth line suspected beyond *F*, may be the third hydrogen line $H\gamma$.

It should be remarked that with the dispersion used, and the width of slit required to see the lines at all satisfactorily, the limits of error may be sufficiently great to bring in two or more competitors for a particular line; recourse must then be had to collateral evidence.

In the cases of the red and blue lines there are no sufficiently marked competitors in the immediate neighbourhood, the apparent coincidence with *C F* leaves, therefore, little doubt that these lines in the star are due to hydrogen.

For the yellow line there were at first three candidates. *D*, a nitrogen line on less refrangible side of *D*, and the sun protuberance line; instrumental evidence has pretty satisfactorily narrowed the competition by eliminating the nitrogen line; whether or not the star line is due to sodium or to the substance whatever it be found in sun flames, cannot at present be said; a higher dispersion, when the star has sufficiently increased in brilliancy, will probably settle the point.

One of the green lines is probably due to nitrogen, for although the limits of error might bring in iron as a competitor, the iron line in that position is not a bright one, and would therefore not be seen alone of the large number of lines which iron produces.

The second green line is involved in the group *b*, and may be accounted for by magnesium or nitrogen; the already assumed presence of nitrogen might perhaps lead us to infer that this second line is also due to it, but we know that nitrogen may be certainly indicated by the chief green line alone. Moreover if the conditions were such as to make others of its large number of lines visible, the second green one would not be the first to appear.

On the whole, therefore, it would seem that the bright lines seen in the spectrum of η Argûs, indicate the presence of hydrogen, nitrogen, sodium, and magnesium.

No dark lines have been seen with certainty, one is strongly suspected in the red, and occasionally there is an appearance as if the whole spectrum were crossed by a multitude; this is probably the case (the lines escaping our notice from faintness of the general light), for no star sufficiently bright to give a fairly visible spectrum has been found without dark lines; Secchi has lately seen a bright line in the variable *A* at its maximum. In the case of T Coronæ, both dark and bright lines were seen by Messrs. Huggins and Miller.

As these physicists remark, it is difficult to imagine the condition of a body producing light of this description; we seem driven to the conclusion that the star consists of a solid nucleus, a gaseous envelope *cooler* than the nucleus producing the dark lines, and a second envelope, hotter than the nucleus, accounting for the bright ones.

The sun is not a case in point, for there the bright and dark lines are not seen together. The former are visible only on a small annulus of the disc, and are due to gases cooler than the continuous spectrum giving nucleus, as proved by the fact that on the surface of the sun the corresponding lines are dark.

In the absence of direct evidence from dark lines in its spectrum, we are unable to tell what are the constituents of η Argûs, other than those revealed by the bright lines ; on the supposition, however, that the other substances belong to the series already discovered in the sun, stars, and nebulæ, it is not unimportant to notice that the constituents of the stars in question more or less certainly indicated by the bright lines would, from mechanical considerations, be high up in its atmosphere.

Hydrogen (on a supposition) would mount far above the rest at the extreme limits thereof; nitrogen, sodium, magnesium would follow next in order. It is probable that the bright line character of the spectrum of η Argûs, indicates a commencement of increase in brilliancy; whether or not, however, the star at its minimum retains a condition capable of producing such a spectrum, there can be little doubt that the gases to which the now seen bright line belongs, play a prominent part in the star's variability.

The nebula surrounding η Argûs has been frequently examined ; its spectrum consists of the three well-known bright lines indicating a gaseous constitution, similar to that of the nebula in Orion.

The comparison of a sketch representing part of the nebula as seen last year in the Melbourne reflector, with Sir J. Herschell's Cape drawing has afforded interesting results.

It is well known by those who have devoted much attention to nebula work, that even from the hands of a most accomplished draughtsman minute details are not to be implicity trusted ; when, moreover, to the imperfect representation of the eye-view as seen with a particular instrument is added the disturbing effect of difference of aperture, much caution is required in drawing conclusions from the evidence of observations made with widely different instruments.

In the case before us the sketches differ very widely, not in minute detail only, but in general character over a large space.

In the Cape drawing the star η is immersed in bright nebula; as seen with the Melbourne telescope, it lies on a background almost completely black, and the contour of the nearest bright nebula is pretty sharply marked.

In the Cape drawing the curious lemniscate vacuity is a conspicuous feature, and has its borders almost equally well marked throughout; in the Melbourne sketch the lemniscate is still conspicuous, but the south end is not clearly indicated, for the surrounding nebula in that direction is extremely faint.

Mr. Abbott of Hobartown in the year 1864, and Mr. Powell of Madras, about the same time called attention to the fact that the star η was completely outside the bright nebula, and that the south end of lemniscate had disappeared.

The instruments used by these observers were, however, so inferior in power to Sir. J. Herschell's 18 inch, that it was not unreasonable to suppose the change merely apparent, due regard being had to the fact that the difference in the representation was precisely of a nature to be accounted for by the difference of instrumental means employed.

With the Melbourne telescope the conditions are reversed, yet Sir J. Herschell saw bright nebula where with a much more powerful instrument, either none at all is seen, or a very faint one barely suspected.

The presence of a bright star has, however, a large disturbing effect (increased by aperture) in apparently obliterating even bright nebula in its immediate neighbourhood; and although the effect could not possibly spread over such a large space as that over which change appears to be indicated, it was not unimportant to get some further proof of the nature of the background on which η is situated. The spectroscope here comes to our aid; the excessively faint nebulosity over the region in question is incompetent to show even a trace of bright lines, and when by shifting the spectroscope the bright lines do appear, it is in positions which indicate that the eye-view configuration represents the actual facts.

These proved facts, therefore, being that the star η is on a background almost completely dark; that the south end of the lemniscate opens out into a space almost as vacuous as itself; it is difficult to imagine any conditions instrumental or atmospheric which could produce an appearance at all approaching to that seen by Sir J. Herschell at the Cape.

We have, therefore, evidence entitled to much weight that enormous changes have taken place in the nebula since the year 1838.

Besides the difference in general features above considered, there are others, notably the presence in the Melbourne sketch of a pair of bright wings at the N. extremity of the lemniscate, which are not indicated in the Cape drawing; this, however, and other differences of detail are in the direction to be accounted for by difference of aperture used, no certain conclusion can therefore be yet drawn therefrom.

Art. IV.—*Decay of Gaspipes in certain Soils.*

By G. Foord, Esq.

[Read 14th February, 1870.]

In September, 1867, it became the duty of the writer of this note to inquire into the cause of the decay of a gas-main, the property of the city of Melbourne Gas Company. The scope of the question submitted did not, at that date, extend beyond its purely commercial sense; but as there appears good reason for regarding the particular case as typical, and significant in reference to the broad subject of the "life" of gas and water mains, and because the subject has a scientific interest quite apart from its purely economic sense, I venture to lay before your Society such results as happen to be at this date at my command. In doing this, I wish to state that the particulars which I have to communicate are slight and imperfect; that no pretentions to a close investigation are set up; and that I should not have risked the presentation, for registration, of so imperfect an account of a fact of confessedly great intrinsic interest, if I had not been encouraged by your President with the assurance that your Society is always ready and anxious to receive and record matters of fact and scientific interest, even though the observations may happen to be of a disjointed and casual character. I confess a personal concurrence in those views, for in our new continent, over the expanse of which promising objects, inviting observation, are so abundant, but in which the number of precise observers are, relatively to the field of inquiry, so few, doubtless for some time to come, observation, as distinguished from methodical research and experiment, must take the lead; and the record of casual observations, even when unsupported by any extent of continuous inquiry or systematic experiment, must prove ultimately valuable. It is this conviction, coupled with the personal assurance of your President, which tempts